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Provincial Report

Chemistry 30

Grade 12 Diploma Examination

September 1984

Student Evaluation

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PREFACE

This report presents the provincial results of the Chemistry 30 Diploma Examination administered on June 26, 1984. During this second administration, the Chemistry 30 Diploma Examination was written by 7948 students. This report provides information about the examination development process, the examination itself, and the examination results.

ACKNOWLEDGMENTS

This second administration of the Chemistry 30 Diploma Examination was successful due to the concerted effort of all involved. Success would have been impossible without substantial contributions from many people, particularly the administrators, teachers, and students, who extended their full co-operation.

The technical expertise and advice received from the Examination Review Committee regarding design, development, and reporting have been particularly valuable in the implementation of this diploma examination. This Committee has representation from:

The Alberta Teachers' Association
The Conference of Alberta School Superintendents
The Universities Co-ordinating Council
The Public Colleges of Alberta
Alberta Education

The contribution of this group is gratefully acknowledged.

Lloyd E. Symyrozum
Director
Student Evaluation Branch

CHAPTER 1

Grade 12 Diploma Examinations Program

Introduction

All Grade 12 students in Alberta are required to write at least ONE diploma examination to receive a high school diploma. Mature students may receive credits for a Grade 12 course by writing the appropriate diploma examination. They are not required to be registered in the course. The Grade 12 Diploma Examinations Program, which is an integral part of the high school diploma requirements, is intended to develop and maintain excellence in educational standards through certification of academic achievement.

The Diploma Examinations Program consists of course-specific examinations that are based on the prescribed *Program of Studies for Senior High Schools* for the following Grade 12 courses: English 30, English 33, Social Studies 30, Mathematics 30, Biology 30, Chemistry 30, and Physics 30.

Alberta Education issues two distinct high school diplomas: the General High School Diploma and the Advanced High School Diploma.

General High School Diploma

To earn a General High School Diploma, a student must obtain course credit in either English 30 or English 33, and obtain 100 credits distributed over courses as specified in the *Junior-Senior High School Handbook*. Some students who are working toward the general diploma may wish to obtain credits in other diploma examination courses (i.e., Social Studies 30, Mathematics 30, Biology 30, Chemistry 30, and Physics 30). To obtain credits in these courses, a student must also write the appropriate diploma examination regardless of the type of diploma he wishes to receive.

Advanced High School Diploma

The Advanced High School Diploma represents achievement in an academic program that includes language arts (English), social studies, mathematics, and science. To earn an Advanced High School Diploma, a student must satisfy the current course and credit requirements for a General High School Diploma, and obtain course credits in English 30, Social Studies 30, Mathematics 30, and ONE of Biology 30, Chemistry 30, or Physics 30.

Awarding of Course Credits

Grade 10 and Grade 11 Courses. To obtain credits in Grade 10 (10-level) and Grade 11 (20-level) courses, a student must earn a final mark of 40% or better. A student who has achieved a mark of 50% or higher in a given course is eligible to take the next or higher-rank high school course in that sequence.

Grade 12 Courses. To obtain credit in a Grade 12 (30-level) course, a student must earn a final mark of 50% or better. To obtain credit in a Grade 12 diploma examination course, a student must write the appropriate diploma examination and attain a final blended mark of 50% or better. The final blended mark is made up of 50% of the mark awarded by the school and 50% of the diploma examination mark. For example, a student taking Chemistry 30 might have a mark of 45% from his school and a mark of 57% on the diploma examination. This student would earn credits for Chemistry 30 because his final mark would be 51%, which is the average of the school and examination marks. For mature students who do not have a school mark or who have a school mark lower than the examination mark, the examination mark is the final mark.

Transitional Provisions

During the 1983/84 school year, Alberta Education will recognize all course credits earned prior to September 1, 1983, for the purpose of awarding the General High School Diploma.

A student who has completed partial requirements for the Advanced High School Diploma prior to September 1, 1983, and who is enrolled in Grade 12 courses during the 1983/84 school year, may apply any of the previously completed required diploma examination subjects toward a diploma provided that the student has earned a final course mark of 50% or better in each subject.

Award of Excellence

When candidates for an Advanced High School Diploma obtain a final average of 80% or higher on the four required diploma examination courses with not less than 65% in any one of these four required courses, they receive an Award of Excellence. This Award of Excellence is noted on the student's Advanced High School Diploma.

When a student writes two or three of the diploma examinations in Biology 30, Chemistry 30, and Physics 30, the highest of these final course marks is used for diploma purposes and in the calculation of the average for the Award of Excellence.

CHAPTER 2

Description of the Examination

This chapter outlines the procedures that were followed during examination development and describes the structure and content of the examination.

Examination Development

There were three stages in the development of the June 1984 Chemistry 30 Diploma Examination: preparation of curriculum specifications, development of questions, and selection of questions for the final copy.

1. Curriculum Specifications

   The Curriculum Branch of Alberta Education prepared curriculum specifications based on the topical outline of the Chemistry 30 core described in the *Program of Studies for Senior High Schools*. In these specifications, weightings were assigned to each major course content area and to specific topics outlined in the *Program of Studies*. These weightings were based on the emphasis that each topic was to receive in the Chemistry 30 program. The curriculum specifications were distributed to all school jurisdictions in the province.

   Topic statements upon which specific questions were based, along with sample questions for each topic, are given in this chapter.

2. Development of Questions

   Committees composed of teachers and Student Evaluation Branch personnel constructed questions to reflect the content statements listed in the curriculum specifications. The questions were field-tested and revisions were made on the basis of teacher recommendations and the field-test results.

3. Final Copy

   A test development specialist, assisted by groups of classroom teachers, built the examination from suitable questions. These committees selected questions from various content areas so that each area received the emphasis recommended in the curriculum specifications. An Examination Review Committee checked the proposed examination for content validity, accuracy, and technical merit, and further changes were made in accordance with their recommendations.

Examination Description

On the June 1984 Chemistry 30 Diploma Examination, each content area received the following emphasis:

Content Area	Emphasis in % of the Total Examination Mark
Chemical Energetics	33
Acids and Bases	32
Oxidation-Reduction	35

To the extent that paper-and-pencil testing permitted, the Chemistry 30 Diploma Examination assessed the application of the scientific process skills of identifying variables, defining in operational terms, inferring, organizing and presenting data, and evaluating experimental designs. The questions that are readily identified with specific process skills are listed below.

Process Skill	Multiple-Choice Question	Written-Response Question
Identifying variables	7	
Defining operationally	19	
Inferring	5, 8, 31	
Organizing and presenting data		2b
Evaluating experimental designs	17	2c

Understandably, the experience gained by direct, hands-on activities are difficult to measure outside a laboratory situation and should therefore be reflected in student performance as evaluated by the teacher.

Subject matter in the attitudinal and psychomotor components of the program was excluded from the diploma examination.

The time allotted for writing the Chemistry 30 Diploma Examination was two and one-half hours. The examination consisted of both multiple-choice questions (worth 80% of the total examination mark) and written-response questions (worth 20% of the total examination mark). There were 55 multiple-choice questions worth one mark each and four written-response questions worth a total of 15 marks.

The classification of examination questions according to subject matter area and cognitive level is presented in Table 1.

Table 1

June 1984 Chemistry 30 Diploma Examination Blueprint

Subject Matter Area	Question by Cognitive Level			Examination Emphasis
	Knowledge	Application and Understanding	Higher Mental Activities	
Chemical Energetics	1,2,3,5,10,11, 13,14,18	4,6,9,12,15,16 [1]	7,8,17	33%
Acids and Bases	19,22,23,24,26, 28,30,34	20,21,25,27,29, 32,33,36 [2a]	31,35, [2b,c]	32%
Oxidation-Reduction	38,42,45,49,51, 52	37,39,40,41,43, 44,46,50,53,54, 55 [3] [4]	47,48	35%
Examination Emphasis	33%	53%	14%	100%

Note: Numbers in brackets [ ] indicate the written-response questions.

Explanation of Blueprint Thought Levels

1. Knowledge

   Knowledge is defined as including those behaviors and examination situations that emphasize the remembering, either by recognition or recall, of ideas, material, or phenomena. Incorporated at this level is knowledge of terminology, specific facts (dates, events, persons, etc.), conventions, classifications and categories, criteria, methods of inquiry, principles and generalizations, and theories and structures.

2. Application and Understanding

   Application requires the student to apply an appropriate abstraction (theory, principle, idea, method) to a new situation.

Understanding refers to responses that represent a comprehension of the literal message contained in a communication. This means that the student is able to translate, interpret, or extrapolate. Translation refers to the ability to put a communication into another language. Interpretation involves the reordering of ideas (inferences, generalizations, or summaries). Extrapolation includes estimating or predicting based on an understanding of trends or tendencies.

3. Higher Mental Activities

Included in higher mental activities are the processes of analysis, synthesis, and evaluation. Analysis involves the ability to recognize unstated assumptions, to distinguish facts from hypotheses, to distinguish a conclusion from statements that support it, to recognize which facts or assumptions are essential to a main thesis or to the argument in support of that thesis, to distinguish cause-effect relationships from other sequential relationships, and to recognize the point of view of a writer.

Synthesis involves the production of a unique communication, the ability to propose ways of testing hypotheses, the ability to design an experiment, the ability to formulate and modify hypotheses, and the ability to make generalizations.

Evaluation is defined as the making of judgments about the value of ideas, solutions, and methods. It involves the use of criteria as well as standards for appraising the extent to which details are accurate, effective, economical, or satisfying. Evaluation involves the ability to apply given criteria to judgments of work done, to indicate logical fallacies in arguments, and to compare major theories and generalizations.

The cognitive classification of examination questions may depend on the manner in which the content has been covered in the classroom. A question that is an application question for one class may be a knowledge question for another class.

Questions requiring knowledge of and skill in the processes of science were included throughout the examination and were not associated with any specific topic or thought level.

Description of Subject Matter Areas and Sample Multiple-Choice Questions

The topics that were tested within each subject matter area are listed and sample questions from the test are provided. The correct response for each question is identified with an asterisk, and the percentage of students selecting each response is given.

1. Chemical Energetics

Questions 1 to 18 in the multiple-choice portion of the examination are related to Chemical Energetics. The major concepts involved in this area are:

- each substance has a definite and characteristic heat content or enthalpy
- changes in matter involve a change in energy

In the following two examples the students are required to apply the process skills of identifying variables and stating interpretations. Question 7 requires students to identify the dependent (responding) variable in the given experiment. Question 8 requires students to interpret the data and recognize an exothermic reaction.

Use the following information to answer questions 7 and 8.

> In an experiment to determine the heat of dissolving KOH(s) in $H_2O(\ell)$, the following data were obtained:
>
> mass of KOH(s) = 2.30 g
> mass of $H_2O(\ell)$ in the calorimeter = 100.0 g
> initial temperature of water = 20.3°C
> final temperature of solution = 26.7°C
> time for KOH(s) to dissolve = 43 s

Question 7:

The dependent (responding) variable in this experiment is most likely

Student Responses

16.0%	A.	time
4.0%	B.	mass of $H_2O(\ell)$
14.9%	C.	mass of KOH(s)
65.1%	*D.	temperature change

Question 8:

Which interpretation of the data is justified?

Student Responses

15.2%	A.	The reaction is endothermic.
17.8%	B.	Heat is absorbed by the reaction.
13.3%	C.	The reaction is not stoichiometric.
53.6%	*D.	The reactants have more potential energy than do the products

2. Acids and Bases

Questions 19 to 36 are based on the following major concepts:

- acids and bases can be defined in different ways
- the relative acidity of a solution can be measured
- acid-base reactions involve an exchange of protons

In the following example the students are required to define acids operationally.

Question 19:

In an operational definition of acids, one CANNOT say that they

Student Responses

68.8%	*A.	are bitter to the taste and turn red litmus blue
7.0%	B.	react with baking soda to produce water
17.4%	C.	are sour to the taste and rough to the touch
6.7%	D.	react with magnesium metal to produce $H_2(g)$

In the following example the students are required to draw inferences from the data given in the question. Students must recognize the relationship between the acid and base form of an acid-base indicator.

Question 31:

A weak solution extracted from beetroot reacts with water according to the following equation: $HR(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + R^-(aq)$. In acidic solutions this substance is red, and in basic solutions it is green. A correct inference is that the green substance is

Student Responses

66.0%	*A.	$R^-(aq)$
23.3%	B.	$HR(aq)$
8.7%	C.	$H_3O^+(aq)$ and $R^-(aq)$
2.0%	D.	$HR(aq)$, $H_3O^+(aq)$, and $R^-(aq)$

3. Oxidation-Reduction

Questions 37 to 55 are based on the following concepts:

- redox reactions involve an exchange of electrons
- in a redox reaction the electron loss and gain must balance
- the electrical potential of a redox reaction can be predicted and measured
- redox reactions involve electrical energy

In the following example the students are required to predict whether a spontaneous reaction would occur between an aqueous metallic ion and metals.

Question 47:

A 1.0 mol/L $Co(NO_3)_2$ solution can be stored in a container made of

Student Responses

49.4%	*A.	tin
20.4%	B.	iron
15.8%	C.	chromium
14.2%	D.	zinc

In the following example the students are required to calculate a stoichiometric relationship for a redox reaction.

Question 54:

How many moles of Al(s) can be oxidized by 1 mol of $Cr_2O_7^{2-}$(aq) in an acidified solution?

Student Responses

11.5%	A.	1
77.5%	*B.	2
6.5%	C.	4
4.3%	D.	6

4. Scientific Process Skills

The process skills covered by the examination were:

Identifying variables - identifying the responding variable in an experiment.

Defining Operationally - constructing an operational definition.

Inferring - drawing inferences from data.

Organizing and presenting data - producing suitable graphs.

Evaluating experimental designs - identifying extraneous steps in an experimental design.

Questions 7, 8, 19, and 31 (see pages 7 and 8) are all examples of questions in which students are required to apply the scientific process skills described above.

Written-Response Questions

In this section, students were expected to communicate their answers clearly and identify the steps in their solutions. All answers were to give the correct number of significant figures in calculations and include appropriate units in the final answer.

Each written-response question from the examination is given on the following pages, along with an appropriate answer. The total possible marks for each question are given, as is the average number of marks awarded. The distribution of marks awarded to students for each written-response question is shown in Table 6, Chapter 3.

Question 1 requires students to apply the principles involved in calorimetry and to use hypothetical data to calculate the heat involved in a phase change.

A student who was attempting to calculate the molar heat of fusion of ice dropped an ice cube into a calorimeter containing water. The data obtained are tabulated below.

Mass of ice at 0.0°C	52.8 g
Volume of water in calorimeter	100.0 mL
Temperature of water and calorimeter before ice was added	45.8°C
Temperature of water and calorimeter after ice had melted	2.3°C

a. Calculate the heat lost by the water originally in the calorimeter.

Key:

$$100.0\ g \times 4.19\ \frac{J}{g \cdot °C} \times 43.5°C$$

$$= 1.82 \times 10^4\ J \text{ or } 18.2\ kJ$$

b. Calculate the heat gained by the cold water that formed when the ice melted.

Key:

$$52.8\ g \times 4.19\ \frac{J}{g \cdot °C} \times 2.3°C$$

$$= 5.1 \times 10^2\ J \text{ or } 0.51\ kJ$$

c. Calculate the molar heat of fusion (melting) of ice.

Key:

heat lost = heat gained
water ice melting + water

$$18.2\ kJ = (\text{moles} \times \text{molar heat of fusion}) + 0.51\ kJ$$

$$18.2\ kJ = \frac{52.8\ g}{18.0\ g/mol} \times \Delta H_{fus} + 0.51\ kJ$$

$$17.7 = 2.93\ mol\ \Delta H_{fus}$$

$$\Delta H_{fus} = \frac{17.7\ kJ}{2.93\ mol}$$

$$\Delta H_{fus} = 6.04\ kJ/mol$$

It was possible to score 5 marks for this question. The average number of marks awarded to students was 2.1.

Question 2 requires students to calculate the volume of base necessary to reach the endpoint in an acid-base titration, determine the shape of the titration curve given the data and predict which indicator would be appropriate to show the endpoint.

20.0 mL of a 0.020 mol/L HCl solution were titrated with a 0.010 mol/L KOH solution.

a. Determine the volume of base solution required to reach the endpoint.

Key:

$$\text{moles of acid} = 0.020\ \text{L} \times 0.020\ \text{mol/L}$$

$$= 0.00040\ \text{mol}$$

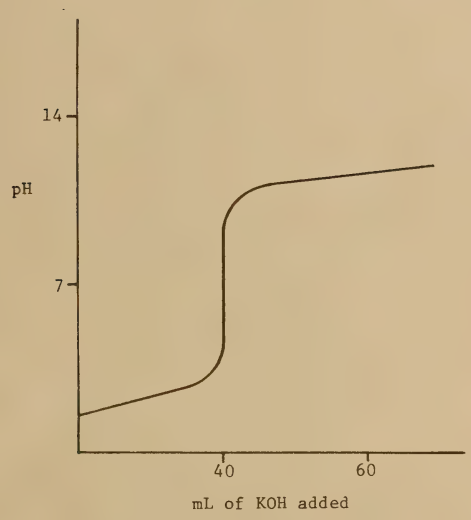
$$\text{moles of base} = \text{moles of acid}$$

$$\text{volume of base} = \frac{0.00040\ \text{mol}}{0.010\ \text{mol/L}}$$

$$= 0.040\ \text{L or } 40\ \text{mL}$$

b. Draw a titration curve for the reaction and label the axes.

Key:



c. Suggest an indicator that would be appropriate for this titration.

Key: bromothymol blue (or chlorophenol red or phenol red or phenolphthalein or methyl red or litmus)

It was possible to score 4 marks for this question. The average number of marks awarded to students was 2.3.

Question 3 requires students to write and balance a redox equation and to determine quantitative stoichiometric relationships.

A sample of tin ore is dissolved in acid and all of the tin is converted to $Sn^{2+}(aq)$. The entire solution is titrated with 0.12 mol/L $Ce^{4+}(aq)$, which oxidizes the tin to $Sn^{4+}(aq)$. $Ce^{4+}(aq)$ is converted to $Ce^{3+}(aq)$ in the reaction. The endpoint is reached when 74.8 mL of $Ce^{4+}(aq)$ have been added.

a. Write a balanced net ionic equation for the reaction.

Key: $2Ce^{4+}(aq) + Sn^{2+}(aq) \longrightarrow 2Ce^{3+}(aq) + Sn^{4+}(aq)$

b. Calculate the number of moles of tin in the ore sample.

Key: moles of $Ce^{4+}(aq)$: $0.12 \text{ mol/L} \times 7.48 \times 10^{-2} \text{ L}$

$= 9.0 \times 10^{-3} \text{ mol}$

moles of $Sn^{2+}(aq)$:

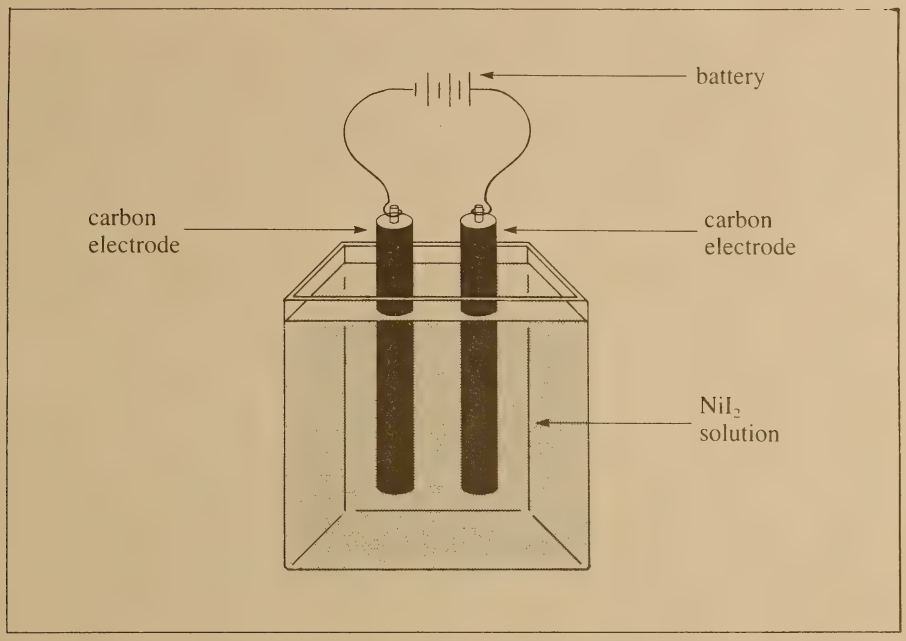
$$9.0 \times 10^{-3} \text{ mol } Ce^{4+} \times \frac{1 \text{ mol } Sn^{2+}}{2 \text{ mol } Ce^{4+}} = 4.5 \times 10^{-3} \text{ mol } Sn^{2+}$$

moles of $Sn^{2+}(aq)$ = moles Sn(s)

moles Sn(s) = 4.5×10^{-3} mol

It was possible to score 3 marks for this question. The average number of marks awarded to students was 1.3.

Question 4 requires students to apply the principles involved in the operation of an electrolytic cell.



a. Write the equation for the half-reaction that would occur at the anode.

Key: $2I^-(aq) \longrightarrow I_2(s) + 2e^-$

b. What product would be formed at the cathode?

Key: Ni(s)

c. What is the theoretical minimum voltage that must be exceeded to make this electrolysis occur at standard conditions?

Key:

$$2I^-(aq) \longrightarrow I_2(s) + 2e^- \qquad E^\circ = -0.54 \text{ V}$$
$$Ni^{2+}(aq) + 2e^- \longrightarrow Ni(s) \qquad E^\circ = -0.23 \text{ V}$$

$$2I^-(aq) + Ni^{2+}(aq) \longrightarrow I_2(s) + Ni(s) \qquad E^\circ = -0.77 \text{ V}$$

minimum voltage necessary = 0.77 V

It was possible to score 3 marks for this question. The average number of marks awarded to students was 1.2.

CHAPTER 3

Results

Validity and Reliability

The content validity of the examination was established by the procedure for examination development outlined in Chapter 2. Each question was mapped to a specific topic statement defining some aspect of the curriculum. The Examination Review Committee evaluated each question, and the examination as a whole, for content validity.

The KR-20 coefficient for the multiple-choice portion of the examination was 0.90, and Cronbach's alpha for the total test was 0.92. These values are very satisfactory for an achievement test measuring a broad range of concepts and skills.

The inter-marker reliability for the marking of the written-response questions was also examined. The marking key for each question was prepared by the Student Evaluation Branch and then revised following discussion with fourteen head markers. During the orientation session, teachers marked three common student responses for each question and discussed the awarding of marks. All teachers then marked an additional three student responses for each question so that the consistency of the marking procedures could be checked. At the beginning of each morning and afternoon marking session, all teachers marked two common student responses for each question. Any discrepancies were again discussed. For questions on those papers marked by all teachers, 95.4% of the marks awarded were in agreement, 4.3% deviated from the consensus mark by one mark, and 0.3% deviated by two marks. During the marking, one marker scored question 1 and 4, and a different marker scored questions 2 and 3 for each paper.

Provincial Averages

The classification of examination questions according to subject matter topic and taxonomic level has been presented in Table 1, Chapter 2. Subtest scores were computed for each of the three subject matter topics, for the three taxonomic levels, and for the questions requiring the application of scientific process skills. Table 2 contains the provincial averages for these subtests and for the total examination. In each case, an average is given for the written-response questions, the multiple-choice questions, and the combination of the two (total). Averages are based on raw scores, which are the number of marks obtained on each subtest. The total marks possible are identified for the written-response and multiple-choice components of each subtest. For the multiple-choice component of each subtest, the average in per cent is also given.

Averages are based on the results achieved by 7948 students. Differences between total averages and component averages are due to rounding.

Table 2

Provincial Averages for Subtests

Subtest	Total Marks Possible		Raw Score Averages		
	Written-Response	Multiple-Choice	Written-Response	Multiple-Choice	Total
Topics					
Energetics	5	18	2.1	12.1 (67.0%)	14.2
Acids and Bases	4	18	2.3	13.0 (72.4%)	15.3
Oxidation-Reduction	6	19	2.5	12.6 (66.5%)	15.2
Process Skills	3	6	1.5	4.0 (66.7%)	5.5
Cognitive Levels					
Knowledge	0	23	--	16.1 (69.8%)	16.1
Application & Understanding	12	25	5.4	17.3 (69.3%)	22.8
Higher Mental Activities	3	7	1.5	4.3 (62.0%)	5.8
Total Examination	15	55	6.9	37.7 (68.6%)	44.6

The standard deviation for the total examination was 12.7 raw score points.

The multiple-choice averages in per cent provide an indication of how well students performed within subject matter topics and cognitive levels. The average for all questions on acids and bases is above the overall average. The average for the questions requiring higher mental activities is below the overall average for multiple-choice items.

It is not meaningful to compare total subtest scores or written-response subtest scores across topics or cognitive levels because of the uneven distribution of written-response questions. However, jurisdictions and schools can compare their averages to the provincial averages to help identify strengths and weaknesses in their programs.

Comparison of Multiple-Choice and Written-Response Questions

The average mark attained on the multiple-choice section of the examination was 68.7%, and the average mark attained on the written-response section was 46.2.%

Where applicable, each written-response question is discussed in relation to comparable multiple-choice questions.

There is little comparison between the multiple-choice sections on Chemical Energetics and question 1 in the written-response section. Although multiple-choice questions 15 and 16 both deal with calorimetry calculations as does written-response question 1, the context is different. Any difficulty students might have experienced with question 1 is very likely due to failing to comprehend the experimental aspects involving the fusion of ice. Questions 15 and 16 are relatively straightforward heat gained/heat lost calculations.

There is also little comparison between written-response question 2 and the acid-base multiple-choice questions. Questions 32 and 33 involve the titration of a strong acid - strong base, as does written-response question 2. However, question 32 uses the diprotic acid $H_2SO_4(aq)$, and question 2 uses the monoprotic acid, HCl(aq). Question 33 requires a higher level of cognitive reasoning than does question 2, because of the four alternatives used in the multiple-choice question.

Multiple-choice question 35 and written-response question 2b require students to design a titration curve for an acid-base titration.

Comparable Questions	Difficulty Levels
written-response 2b	0.46
multiple-choice 35	0.61

Multiple-choice question 27 and written-response question 2c require students to predict the indicator that can be used to identify the endpoint in an acid-base titration.

Comparable Questions	Difficulty Levels
written-response 2c	0.55
multiple-choice 27	0.83

Multiple-choice question 50 and written-response question 4b require students to predict the species formed at the cathode of an electrolytic cell.

Comparable Questions	Difficulty Levels
written-response 4b	0.48
multiple-choice 50	0.54

Standard-Setting

Every effort was made to design a Chemistry 30 diploma examination that would be a valid and reliable measure of what students can be expected to know as a result of instruction in this course. A specific standard or level of expectation inherent in the examination was established through careful test development procedures.

To ensure equitability among marks awarded to students during the administration of each examination form for 1984, the Student Evaluation Branch adopted a process of standard-setting. One way to review the standards inherent in each examination was to involve classroom teachers in making judgments about the difficulty of the examination.

The teachers who marked the written-response portion of the examination reviewed the difficulty level of each question in terms of borderline passing students (who merit 50%). A judgment was also made regarding borderline "B" students (who merit 65%), and borderline "A" students (who merit 80%). After teachers made their initial judgments on question difficulty, they were given information about the actual distribution of students' examination marks. They were then given the opportunity to modify their judgments.

On the basis of the data derived from the standard-setting procedure and an inspection of school-awarded marks, it was decided that transformation would not be required.

Relationship Between Examination Mark and School Mark

The provincial averages and standard deviations for the school-awarded mark, the examination mark, and the final blended mark are presented in Table 3.

Table 3

Summary Statistics for School Mark, Examination Mark, and Final Mark

	School-Awarded Mark	Examination Mark	Final Blended Mark
Average	65.7%	64.3%	65.8%
Standard Deviation	13.7%	18.1%	15.1%

The average school mark was 1.4% higher than the average examination mark. The correlation between school mark and examination mark was 0.77, which indicates a fairly close agreement in the rank-ordering of the students based on the two sets of marks.

The percentages of students receiving A's, B's, C's, and F's are presented in Table 4 for the school-awarded mark, the examination mark, and the final blended mark.

Table 4

Percentages of Students Receiving A's, B's, C's, and F's

Score	School-Awarded Mark	Examination Mark	Final Blended Mark
A(80-100%)	19.7	23.0	20.7
B(65-79%)	34.4	27.1	32.3
C(50-64%)	34.9	28.5	34.8
F(0-49%)	11.0	21.4	12.2

Results for Individual Questions

Multiple-Choice Questions

The percentage of students choosing each response for each question is given in Table 5. The correct response for each question is also identified.

Table 5

Results for Individual Multiple-Choice Questions

Item	Key	Distribution of Response in %*				Item	Key	Distribution of Response in %*			
		A	B	C	D			A	B	C	D
1	C	4.3	28.7	64.3	2.6	29	C	12.6	16.0	63.7	7.7
2	C	11.3	53.1	24.6	10.9	30	A	72.6	11.6	11.4	4.4
3	B	3.9	48.0	27.3	20.7	31	A	66.0	23.2	8.7	2.0
4	B	8.6	78.3	5.9	7.2	32	B	53.6	30.8	12.4	3.1
5	A	69.8	14.7	8.0	7.5	33	A	69.1	16.6	9.7	4.5
6	C	3.9	11.8	75.3	8.9	34	B	18.2	52.8	6.1	22.8
7	D	16.0	4.0	14.9	65.1	35	B	21.2	61.1	12.1	5.6
8	D	15.2	17.8	13.3	53.6	36	A	66.7	9.7	13.9	9.6
9	A	73.8	20.5	3.3	2.3	37	D	4.2	8.9	10.8	76.1
10	B	4.0	76.7	3.3	15.9	38	A	85.0	11.1	1.6	2.2
11	B	7.7	63.4	25.0	3.9	39	C	16.3	14.3	53.4	15.8
12	A	60.0	15.7	17.7	6.6	40	B	12.9	71.7	8.5	7.0
13	A	77.5	2.5	1.3	18.6	41	B	25.3	54.8	13.9	5.7
14	C	5.7	6.8	85.8	1.7	42	A	77.8	2.9	2.5	16.7
15	D	3.1	10.5	7.3	79.0	43	D	12.7	16.2	20.7	50.1
16	C	4.3	25.2	67.9	2.4	44	B	17.3	65.0	15.2	2.4
17	C	6.4	8.6	76.7	8.2	45	C	4.9	1.9	75.0	18.2
18	A	66.0	3.3	2.0	28.7	46	D	6.1	6.2	9.6	77.9
19	A	68.8	7.0	17.4	6.7	47	A	49.4	20.4	15.8	14.2
20	D	2.6	3.9	1.9	91.6	48	D	8.2	23.6	5.9	62.2
21	C	4.3	3.5	86.7	5.5	49	D	14.7	13.6	22.1	49.6
22	D	9.2	8.9	3.2	78.7	50	A	54.4	34.9	6.5	4.1
23	C	3.1	3.1	87.3	6.5	51	C	19.0	5.0	70.7	5.2
24	C	4.8	9.9	80.0	5.1	52	B	9.5	69.6	10.8	9.9
25	C	3.8	6.5	82.4	7.3	53	D	5.0	13.2	5.5	76.2
26	D	11.2	9.8	3.9	75.1	54	B	11.5	77.5	6.5	4.3
27	D	7.5	6.4	3.4	82.6	55	B	11.3	66.8	7.0	14.2
28	D	1.1	10.1	2.3	86.4						

*The sum of the percentages for each question is less than 100% because the No Response category is not included.

Written-Response Questions

The percentage of students awarded each mark for each question is given in Table 6.

Table 6

Distribution of Marks for Written-Response Questions

Question Number	Percentage of Students Obtaining Each Mark				
	NR*	0	1	2	3
1a	2.6	27.4	70.0		
1b	7.3	60.5	32.1		
1c	9.4	26.7	32.7	17.5	13.6
2a	5.1	13.8	81.2		
2b	7.1	31.9	29.6	31.4	
2c	6.1	39.1	54.8		
3a	10.0	41.5	48.5		
3b	16.5	25.5	32.3	25.7	
4a	5.8	55.7	38.5		
4b	5.3	46.5	48.2		
4c	6.3	60.2	33.5		

*NR - No Response

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The total number of marks ... to students, and the difficulty level for ... summarized in Table 7. The difficulty ... al marks possible.

Table 7

Average Marks Awarded for Written-Response Questions

Question Number	Total Marks	Average	Difficulty Level
1 (total)	5	2.1	0.42
1a	1	0.7	0.70
1b	1	0.3	0.32
1c	3	1.1	0.36
2 (total)	4	2.3	0.58
2a	1	0.8	0.81
2b	2	0.9	0.46
2c	1	0.5	0.55
3 (total)	3	1.3	0.43
3a	1	0.5	0.49
3b	2	0.8	0.42
4 (total)	3	1.2	0.40
4a	1	0.4	0.39
4b	1	0.5	0.48
4c	1	0.3	0.34

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